

# WILDFIRES, SMOKE AND HEALTH EFFECTS

A perspective on wildfire season in western Montana  
Sarah Coefield, November 6, 2013, Montana Asthma Advisory Group

# Summary



- Air quality during the 2012 and 2013 wildfire seasons
- Smoke characteristics and health effects
- Air quality updates and health advisories

# Wildfire activity – it's increasing



# Wildfire Smoke

- Highly variable by location and time
- Particulates and irritating chemicals
- Changes with fire activity
  - ▣ Flare ups
  - ▣ Burn outs
  - ▣ Smoldering

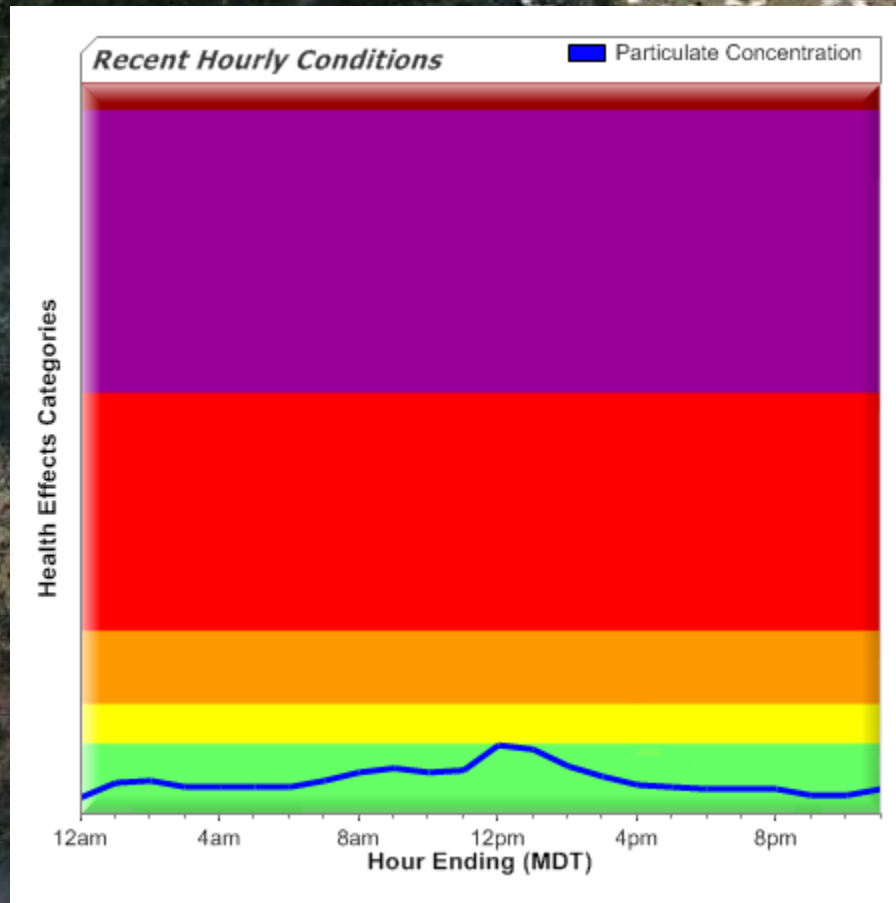


# What are we monitoring during a wildfire?

- Particulate (PM<sub>2.5</sub> and/or PM<sub>10</sub>) concentrations at permanent and temporary monitoring sites.
- The 24-hour National Ambient Air Quality Standard for PM<sub>2.5</sub> is 35 µg/m<sup>3</sup>.
- We start issuing health advisories when the 24-hour average reaches 21 µg/m<sup>3</sup> and/or the 1-hour average surpasses 50 µg/m<sup>3</sup>.

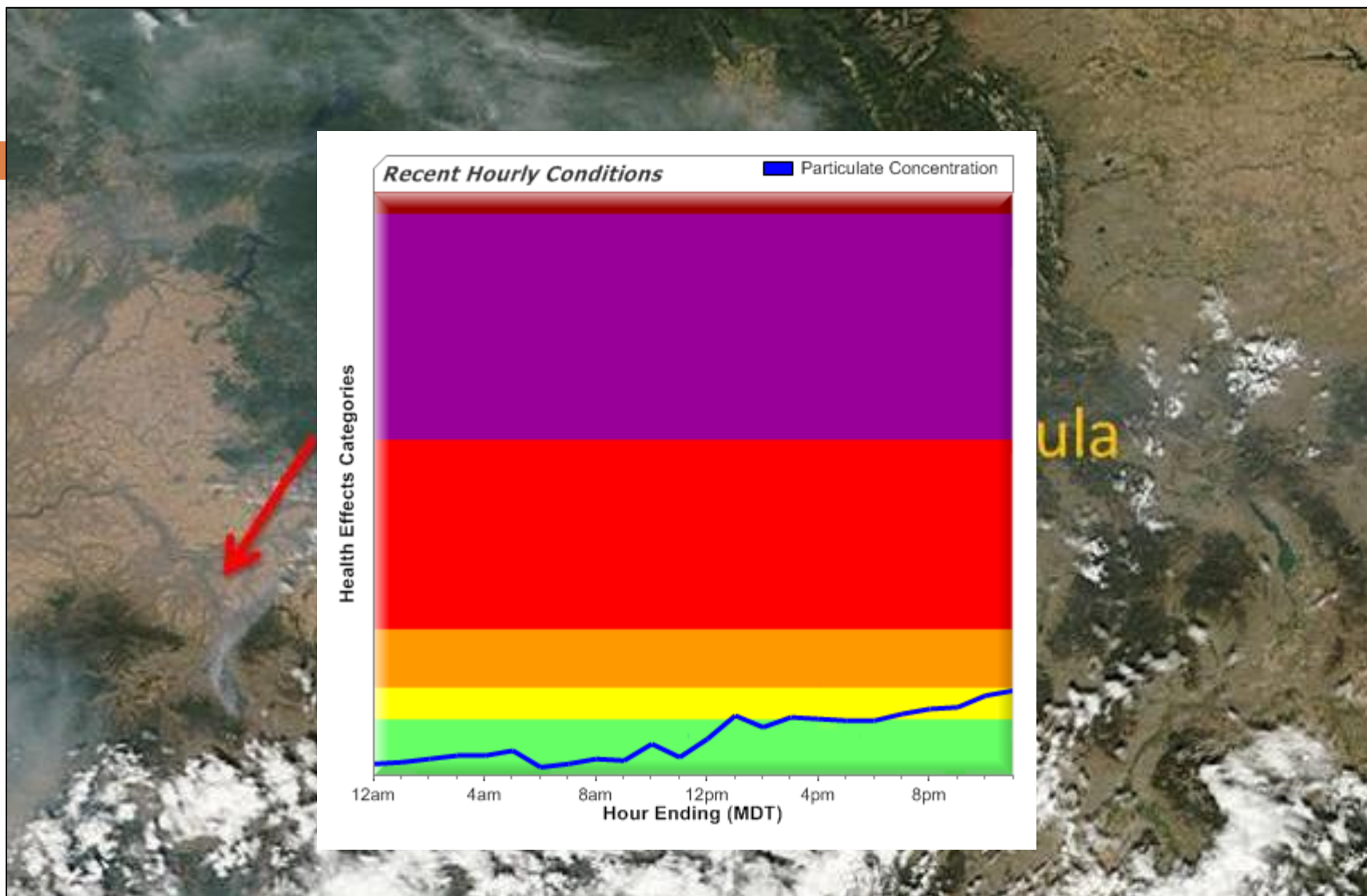
# What makes a bad wildfire smoke day?

- Winds from same direction as the fires
  - ▣ The Selway-Bitterroot Wilderness frequently burns, and sends smoke straight toward Missoula County
- Increased wildfire activity
  - ▣ Creates a plume that lands in the Missoula area
- Stagnant air
  - ▣ High pressure ridge
  - ▣ Inversions



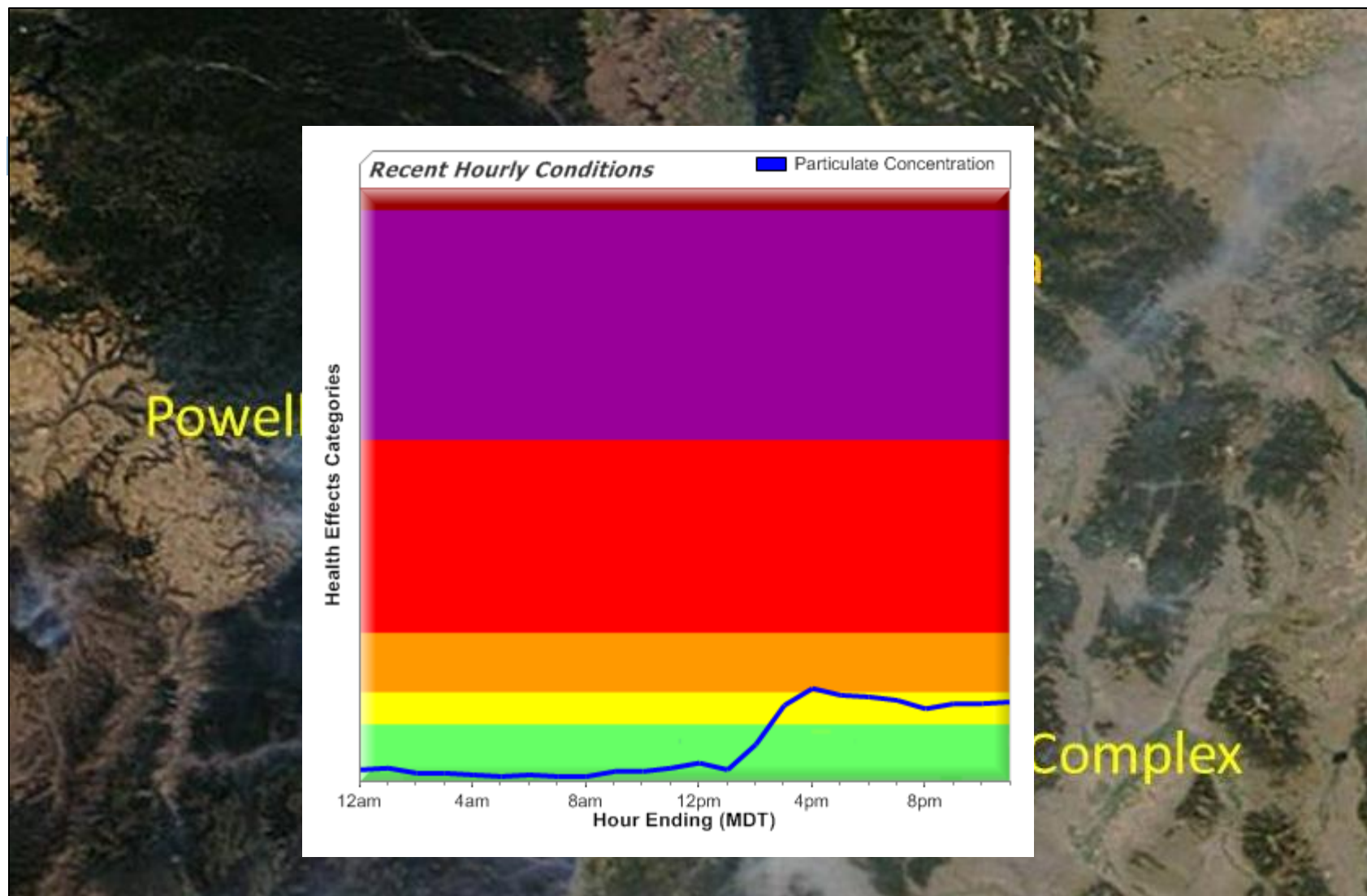
August 14, 2012, 24hr PM<sub>2.5</sub>=16  $\mu\text{g}/\text{m}^3$



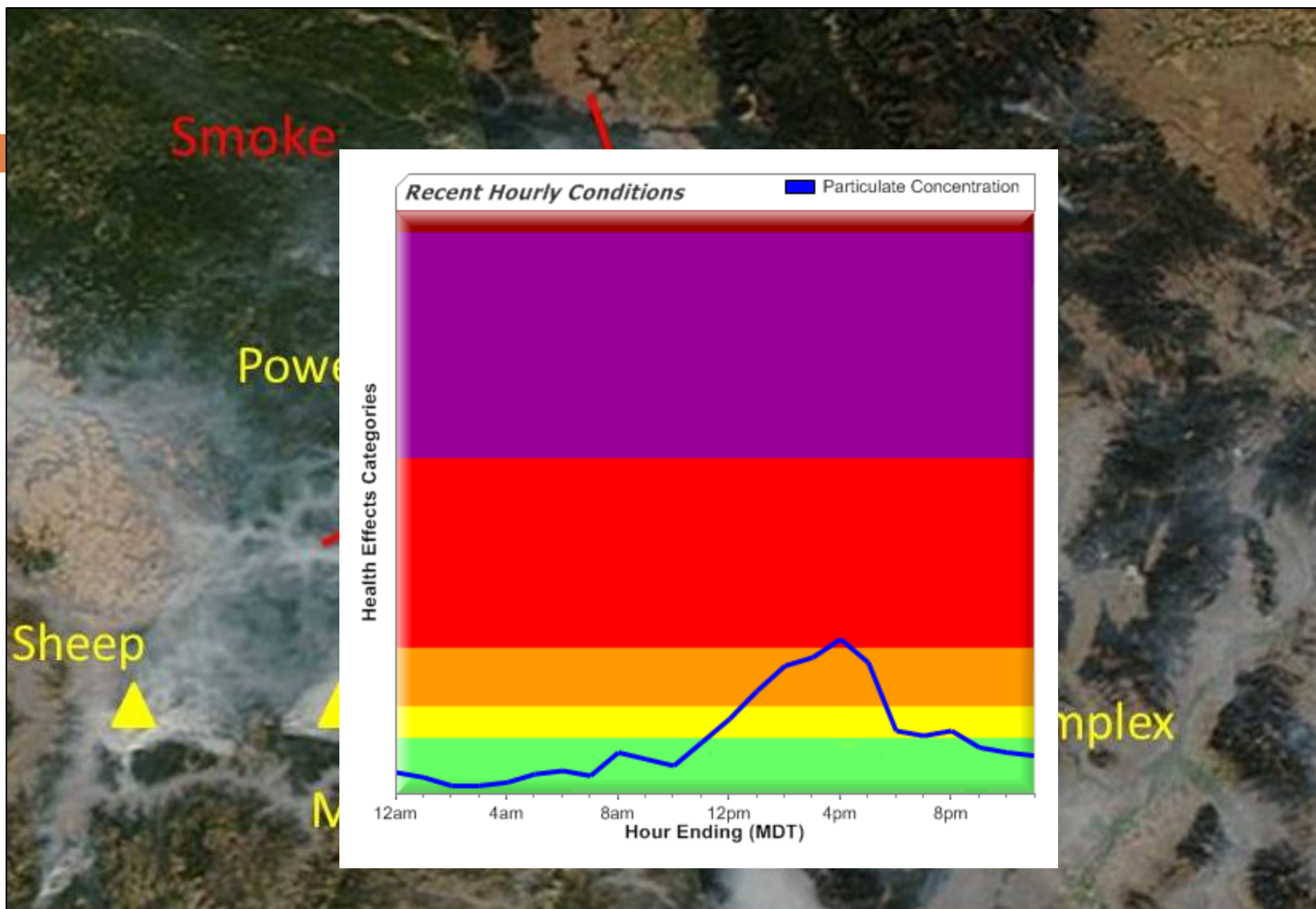


August 26, 2012 , 24hr PM<sub>2.5</sub>=25  $\mu\text{g}/\text{m}^3$

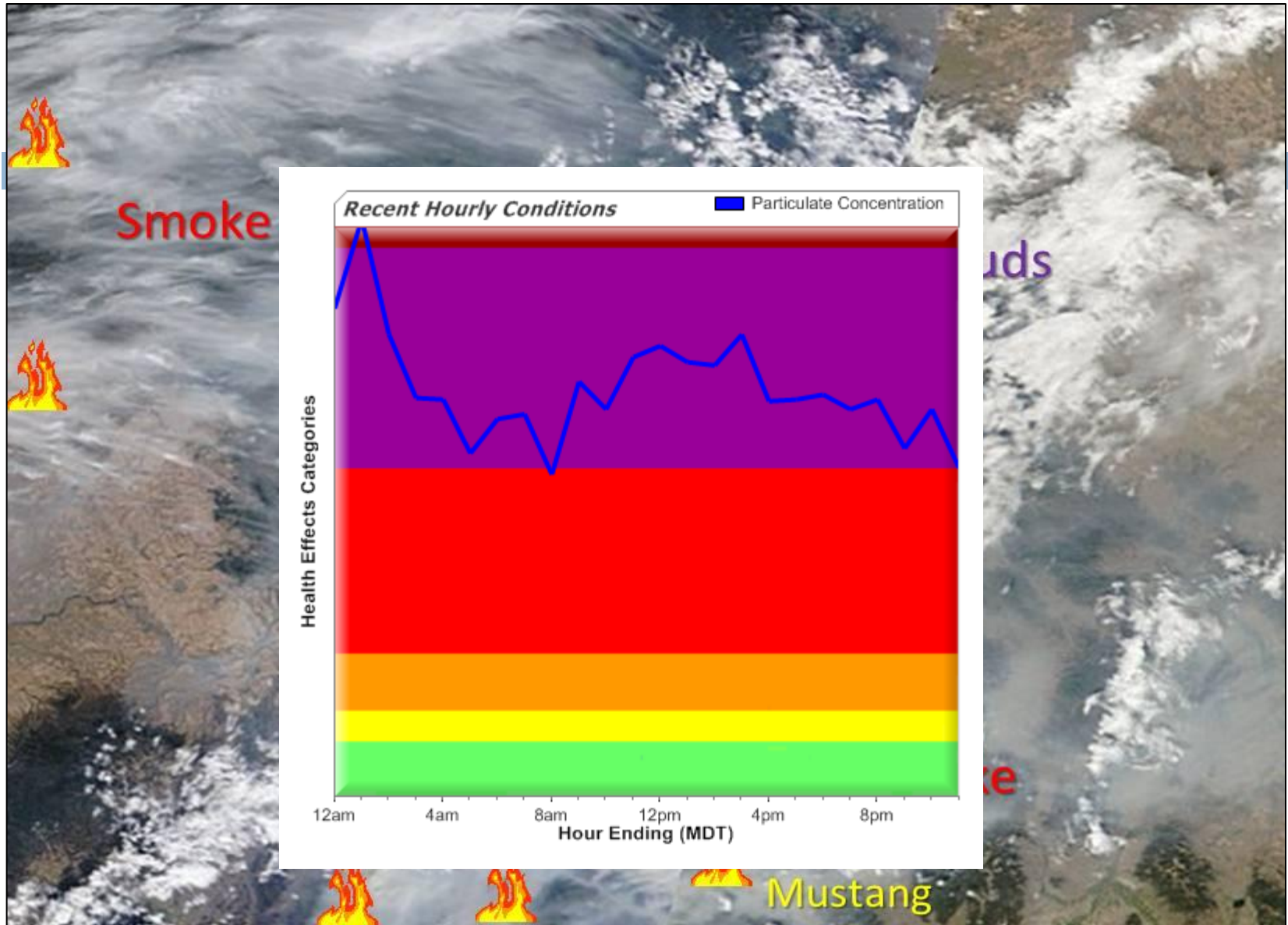




August 30, 2012, 24hr PM<sub>2.5</sub>=24  $\mu\text{g}/\text{m}^3$

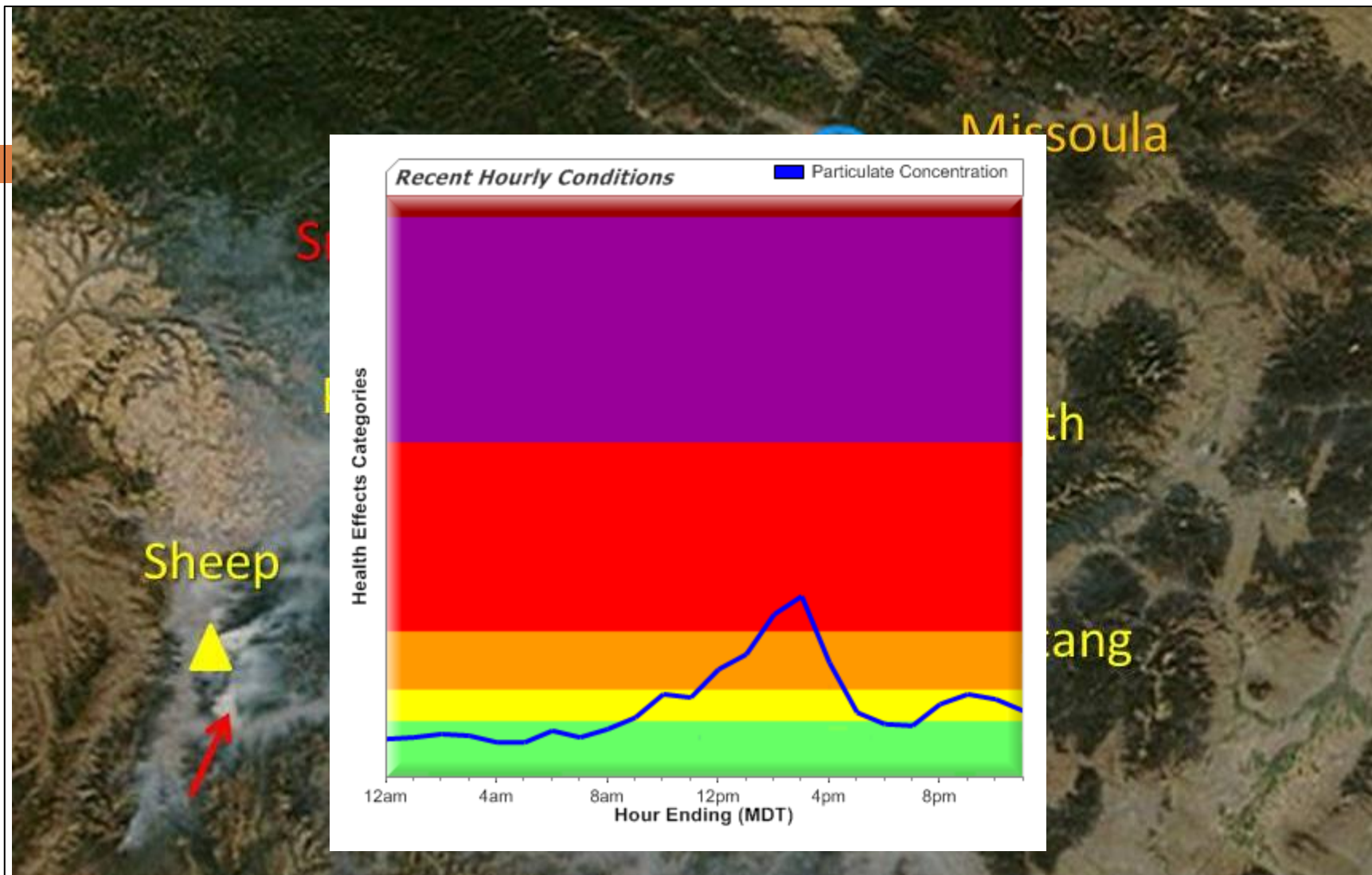


September 13, 2012, 24hr PM<sub>2.5</sub>=34  $\mu\text{g}/\text{m}^3$

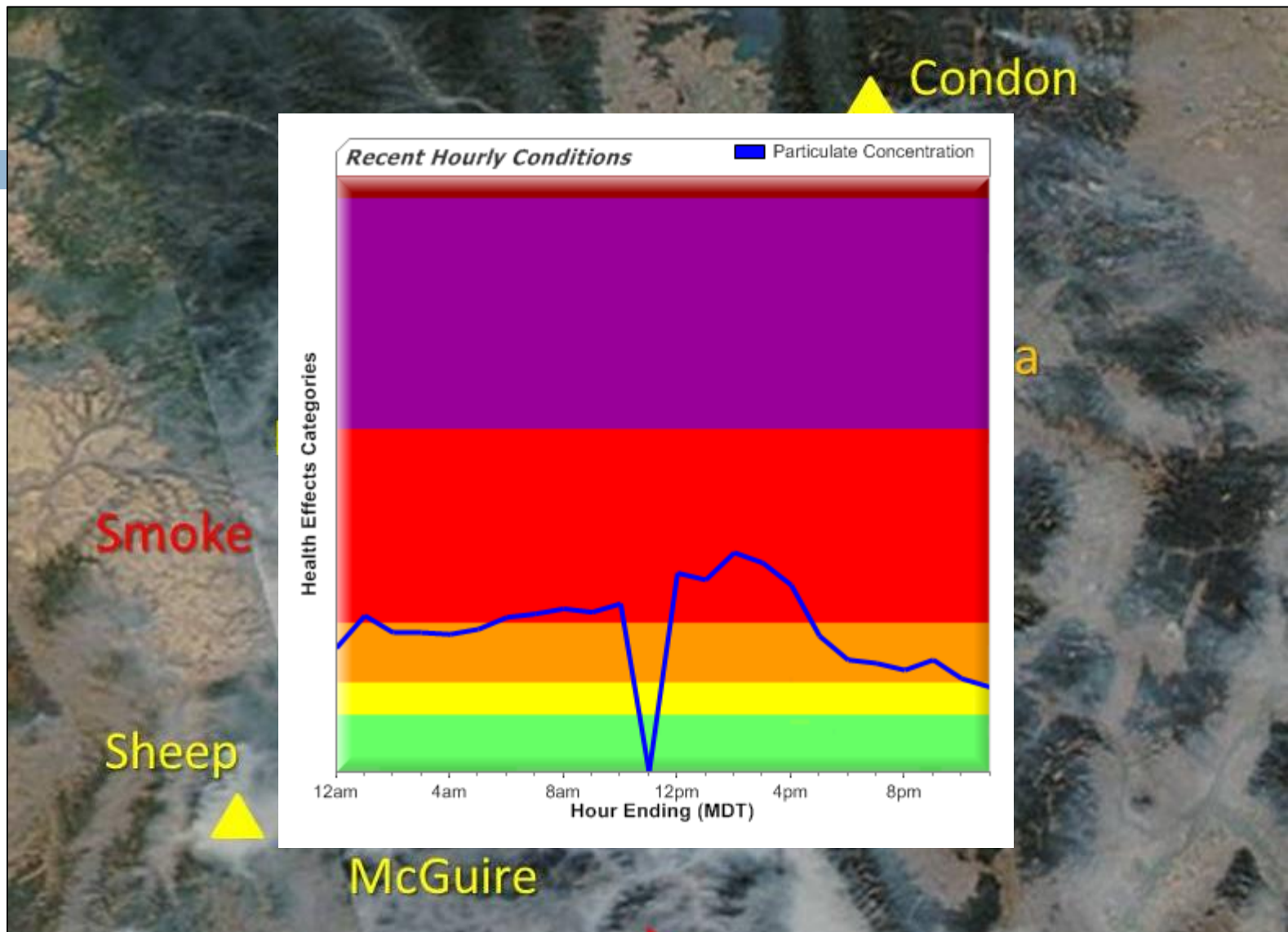


September 15, 2012, 24hr PM<sub>2.5</sub>=108 µg/m<sup>3</sup>





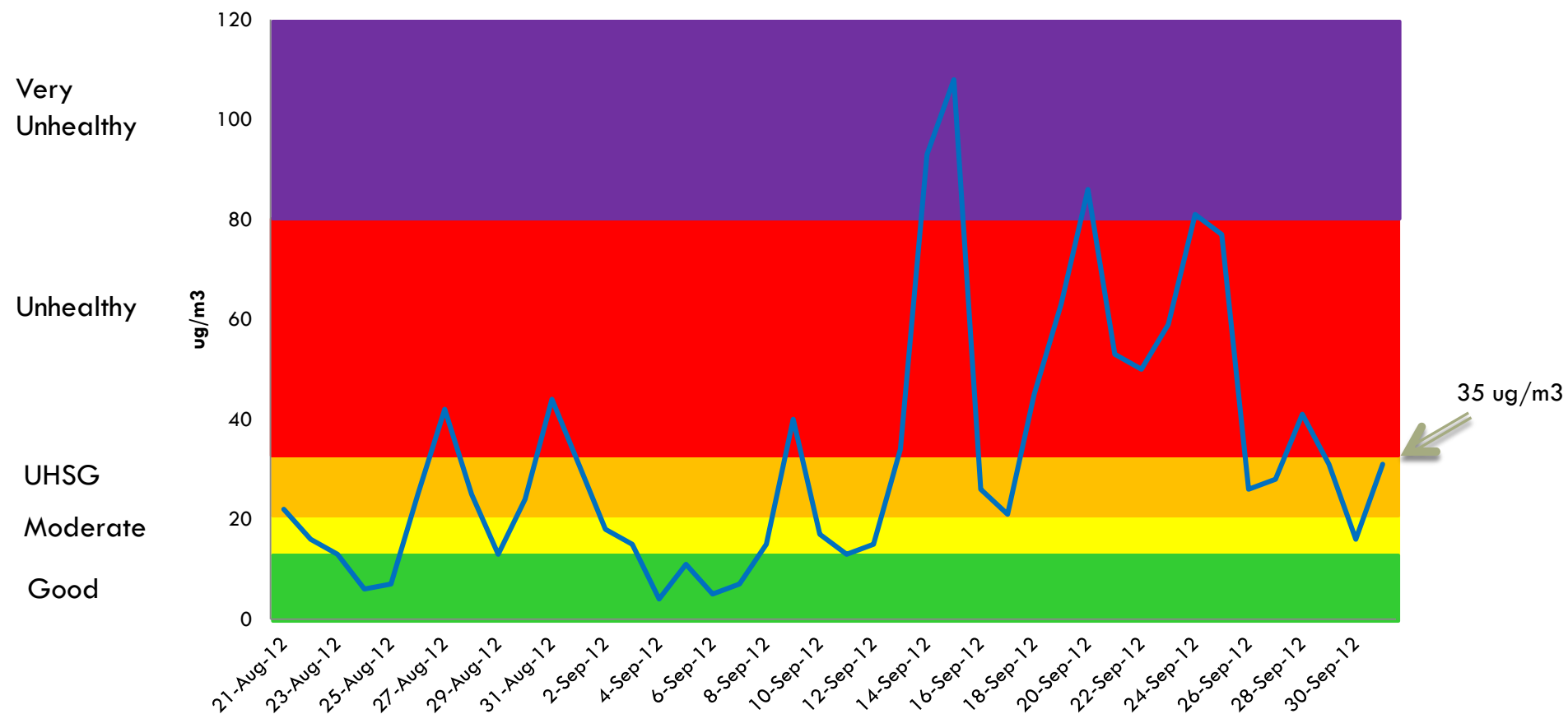
September 18, 2012, 24hr PM<sub>2.5</sub>=45  $\mu\text{g}/\text{m}^3$



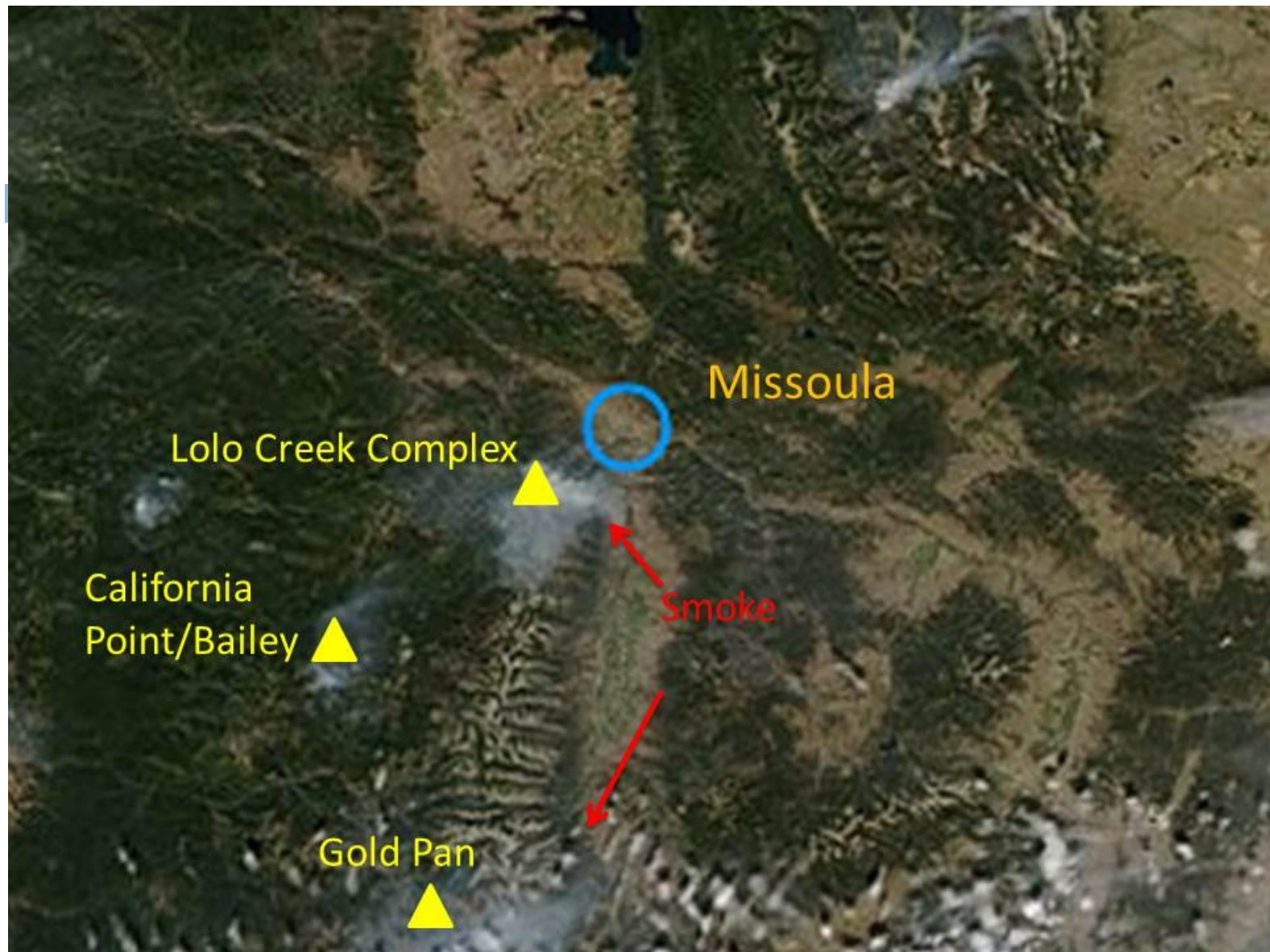
September 20, 2012, 24hr PM<sub>2.5</sub>=86  $\mu\text{g}/\text{m}^3$

# Wildfire smoke and air quality

**Missoula County PM2.5 24-hour average  
August 21 - October 1, 2012**







August 21, 2013, 24hr PM<sub>2.5</sub>=346  $\mu\text{g}/\text{m}^3$









National Forest  
POINT OF  
INTEREST  
→

LOLO HOT SPRINGS 25  
LEWISTON IDAHO 209

# Common questions

- “I own a daycare, how do I know when it’s ok the let the kids play outside?”
- “My son has asthma, what can we do to protect him from the smoke?”
- “We are hosting a track tournament on Saturday. Should we postpone it?”
- “Where can we go in the state where there is less smoke?”

# More common questions

- ▣ “What’s in smoke from a wildfire?”
- ▣ “Is smoke bad for me?”
- ▣ “How can I keep my house less smoky? Do air filters help?”
- ▣ “How long is the smoke going to last?”

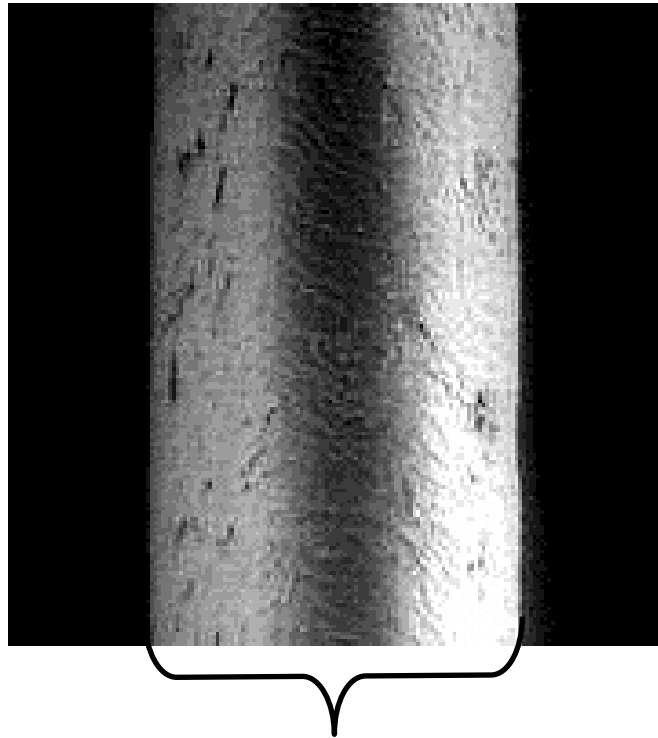
# What is in smoke?

- Particulate Matter – main source of irritants, major health concern
- Acrolein
- Formaldehyde
- Benzene
- Carbon Monoxide
- PAHs



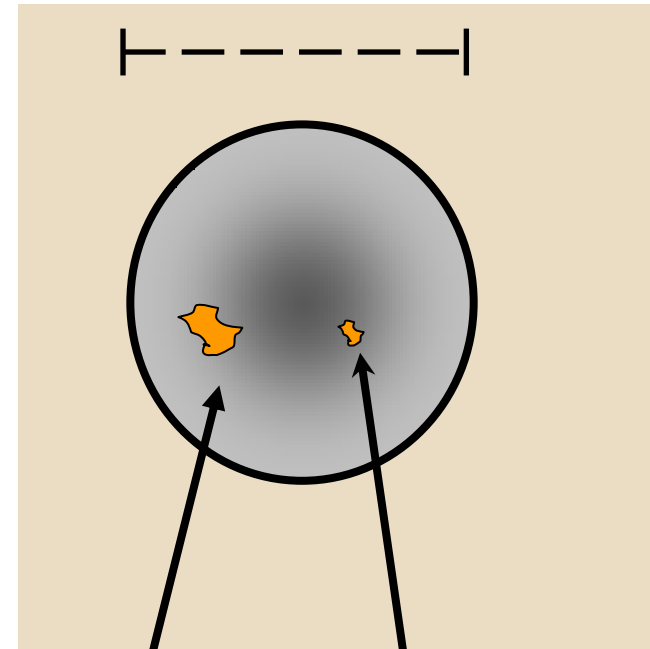
# What are particles?

Airborne particles are a complex mixture of extremely small solids and liquid droplets.



**Human Hair (70  $\mu\text{m}$  diameter)**

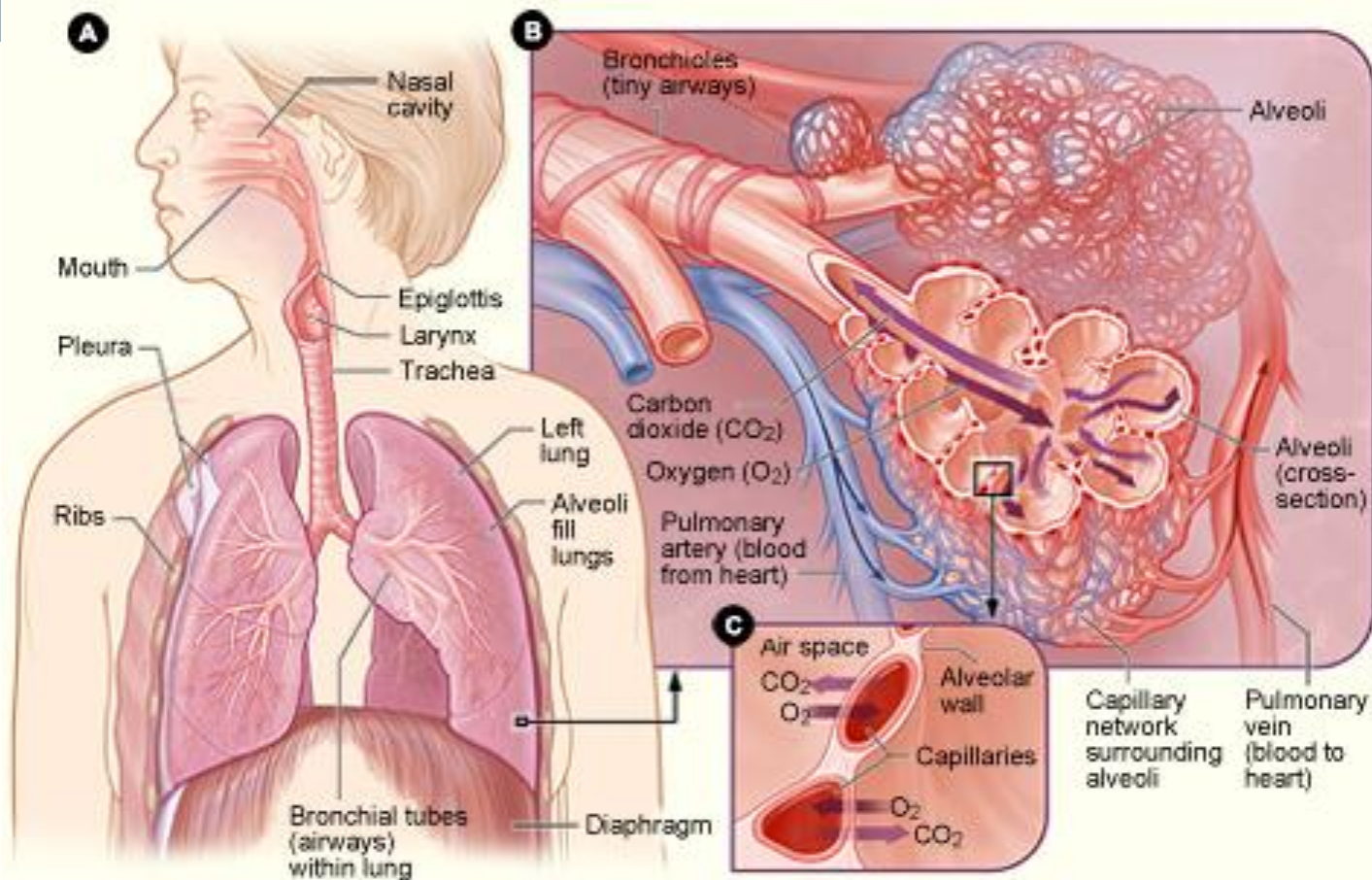
**Hair cross section (70  $\mu\text{m}$ )**



**PM<sub>10</sub>  
(10  $\mu\text{m}$ )**

**PM<sub>2.5</sub>  
(2.5  $\mu\text{m}$ )**

# Respiratory system



# Size Matters

- Small, ultra-fine particles **act like a gas:**  
**penetrate indoors** from outside air,  
penetrate deep into lungs, cross  
alveoli, directly affect blood vessels, heart
- Fine particles have greater aggregate  
surface area: **adsorb toxic combustion**  
**products, metals, atmospheric air toxics,**  
carries them deep into the lung:  
inflammation, cell damage results

# Particulate Matter

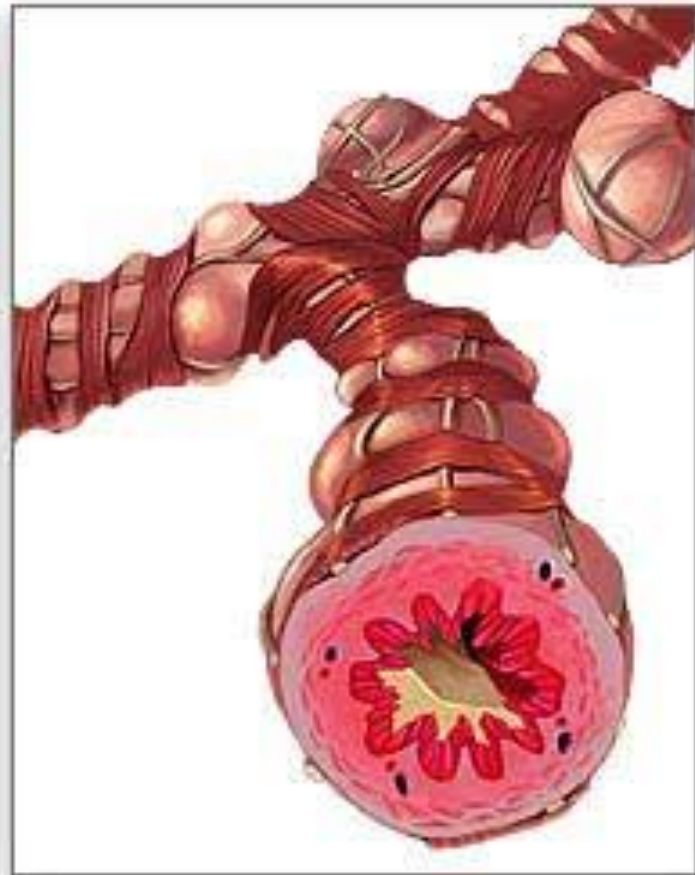
- Particulate matter stimulates inflammation in the lung, and products of that inflammation spill over into the body's circulation, traveling to fat tissue to promote inflammation and cause vascular dysfunction
  - ▣ Inflammation leads to increased frequency and severity of asthma attacks and symptoms, as well as COPD aggravation
  - ▣ The systemic inflammation leads to increased risk of heart attacks and other cardiovascular events

# What does asthma look like?

Normal bronchiole



Asthmatic bronchiole



# Wildfires and respiratory response

- Delfino et al (2009) looked at 40,856 Emergency Department admissions during a California wildfire episode in October 2003.
  - ▣ 34% increase in asthma admissions per 70 $\mu\text{g}/\text{m}^3$  PM<sub>2.5</sub>, strongest relationship in people ages 65+ and children ages 0-4.
  - ▣ Acute bronchitis increased by 9.6% (1.8% -17.9%) per 10  $\mu\text{g}/\text{m}^3$
  - ▣ COPD for ages 20-64 increased by 6.9% (.9% to 13.1%) per 10  $\mu\text{g}/\text{m}^3$
  - ▣ Pneumonia for ages 5-18 increased by 6.4% (-1,% 14.2%) per 10  $\mu\text{g}/\text{m}^3$ .
  - ▣ [Occup Environ Med.](#) 2009 Mar;66(3):189-97. **The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003.** [Delfino RJ,](#) [Brummel S,](#) [Wu J,](#) [Stern H,](#) [Ostro B,](#) [Lipsett M,](#) [Winer A,](#) [Street DH,](#) [Zhang L,](#) [Tjoa T,](#) [Gillen DL.](#)

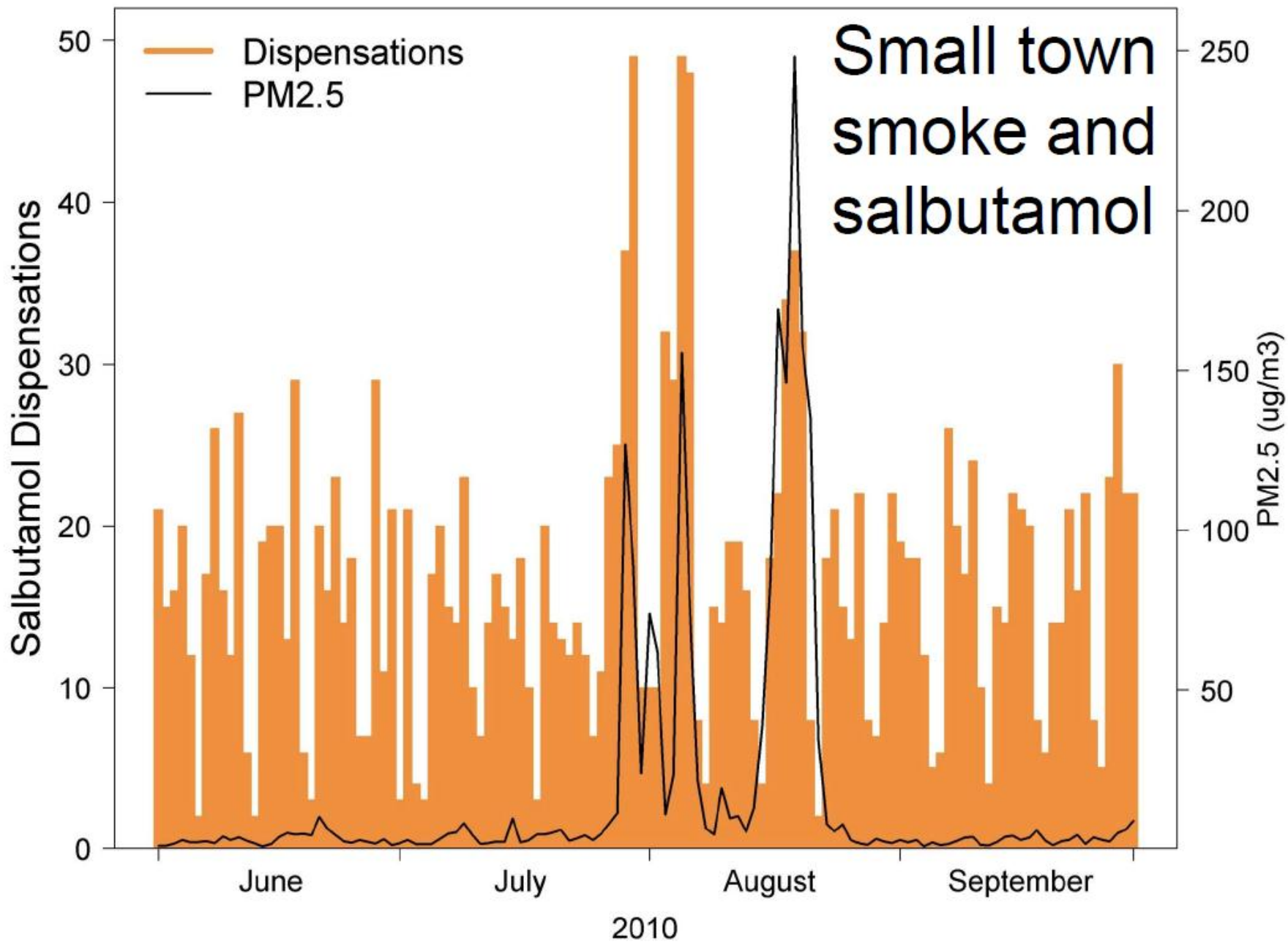


# Bush fire smoke and asthma

- A 10 ug/m increase in bushfire PM10 was associated with
  - ▣ 1.24% increase in all respiratory disease admissions,
  - ▣ 3.80% increase in chronic obstructive pulmonary disease admissions (at lag 2),
  - ▣ 5.02% increase in adult asthma admissions.
  
- Epidemiology. 2010 Jan;21(1):47-55. **Effects of bushfire smoke on daily mortality and hospital admissions in Sydney, Australia.** Morgan G, Sheppeard V, Khalaj B, Ayyar A, Lincoln D, Jalaludin B, Beard J, Corbett S, Lumley T.

# Wildfire and asthma medication

- ▣ Positive association with salbutamol dispensations in a fire affected populations and no associations in areas not affected by the fire
  - Time series analysis of fine particulate matter and asthma reliever dispensations in populations affected by forest fires. Elliott CT, Henderson SB, Wan V., *Environ Health*. 2013



# Smoke and mortality

- **Smoke events were associated with 5% (0% - 10%) increase in non-accidental mortality.**
- Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994-2007 Johnston F, Hanigan I, Henderson S., *Environ Res* 2011

# Acrolein



- Short term symptoms include stinging and tearing eyes, nausea and vomiting.
- Long term exposure risk is: Chronic respiratory disease

# Formaldehyde



- ❑ Short term symptoms include irritated eyes, nose and throat.
- ❑ Long term exposure risk is nasal and nasopharyngeal cancer.



# Benzene



- ❑ Short term symptoms are headaches, dizziness, nausea and breathing difficulties.
- ❑ Long term exposure risks are anemia, liver and kidney damage, and cancer.

# Carbon Monoxide



- ❑ Symptoms include dizziness, nausea and impaired mental function.
- ❑ Body typically recovers quickly from short-term exposure during smoke-free periods.
- ❑ High concentrations cause death.

# Polycyclic Aromatic Hydrocarbons (PAHs)



- ❑ Major carcinogenic (cancer causing) components of smoke
- ❑ Teratogenic: causes birth defects

# Health Effects of Smoke and Elevated Fine Particulate Pollution

- Watery Eyes
- Irritated Respiratory Tract
- Headaches
- Reduced Lung Function
- COPD aggravation
- Asthma attacks
- Pneumonia complications
- Increased Hospital Visits
- Stroke
- Heart Attack





# Sensitive populations

- Smoke levels that are ok for you can pose a serious threat to sensitive individuals
  - ▣ Elderly
  - ▣ Children
  - ▣ Chronically ill
  - ▣ Pregnant women







How many sensitive individuals are in this photograph?

# Protect yourself

## □ YES

- Stay indoors
- Reduce activity levels
- Reduce other sources of indoor air pollution
  - Cigarette smoke, cooking, vacuuming
- Air conditioners and filters
- Room air cleaners
- Create a clean room
- Respirator rated for particulates (N95 or P100)
- Cleaner air shelters
- Evacuation

# Protect yourself (cont'd)

☐ NO

- ☐ Dust mask/bandana
- ☐ Ozone generators



# Air Quality Updates

- Daily updates once wildfire season starts
- Health-based advisories issued 2x/day
  - ▣ Air Quality Hotline: 258-3600
  - ▣ Online:  
<http://www.co.missoula.mt.us/airquality/CurrentAirQuality/currentstatusreport.htm>
  - ▣ E-mail notification list



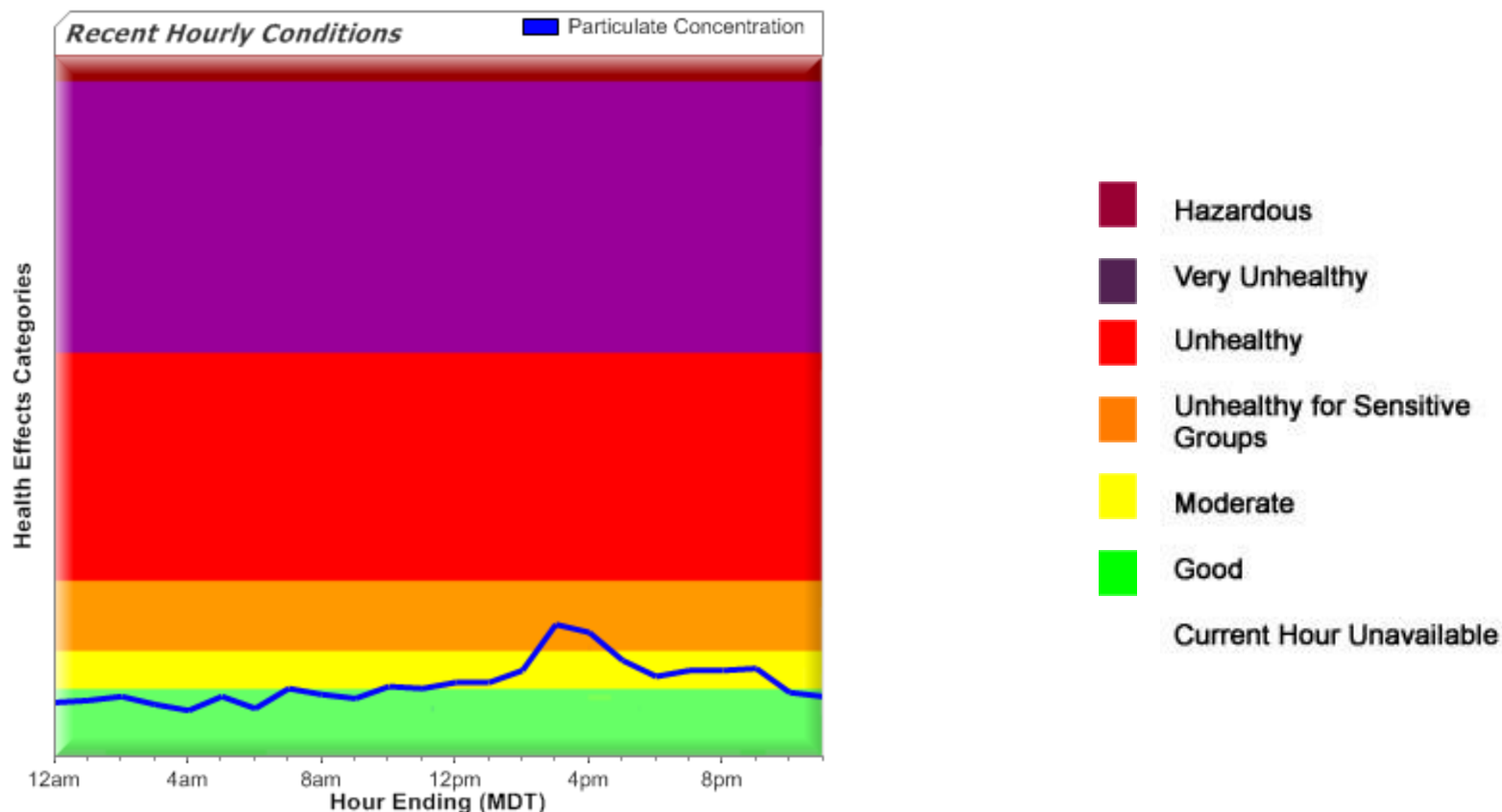
Today's Air Sept. 15, 2011.

Data from 11AM.



<http://todaysair.mt.gov/AirDataMap.aspx>

# Boyd Park Sept. 8, 2011



Continued exposure to particulates can cause adverse health effects, which is why too many hours with particulate concentrations in the “Unhealthy for Sensitive” and “Moderate” ranges resulted in an Unhealthy health advisory on Sept. 8.

# Monitoring smoke behavior

- Close eye on current weather conditions
  - [Mesonet](#)
- Check Today's Air throughout the day
- Visual Observations
- Post mid-day update if conditions worsen

# Air Quality Updates

- **Location-specific health advisories**

- Good
- Moderate
- Unhealthy for Sensitive Groups
- Unhealthy
- Very Unhealthy
- Hazardous

- **Information on what to expect in near future**

- Inversions
- Gusty winds
- Etc.



# Resources

- Wildfire smoke guide for public health officials – useful information about smoke and its health affects. Includes tips for limiting exposure.





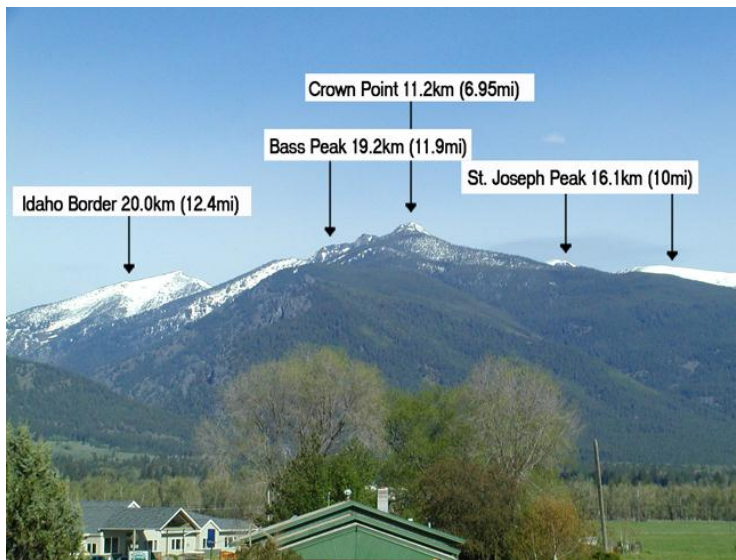
# Assessing Air Quality

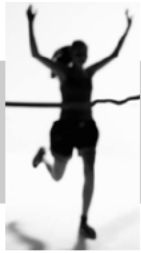
The procedure for approximating PM 2.5 concentration without official monitors:

1. Face away from the sun.
2. Determine the limit of your visible range by looking for targets at known distance (miles). Visible range is that point at which even high contrast objects totally disappear.
3. Use the table values to determine the local forest fire smoke category.

Category	PM2.5 1hr ave. concentration ( $\mu\text{g}/\text{m}^3$ )	Visibility Range (miles)
Good	0.0-33.5	>13.4+
Moderate	33.6-51.0	13.3-8.8
Unhealthy for Sensitive Groups	51.1-88.5	8.7-5.1
Unhealthy	88.6-201.0	5.0-2.2
Very Unhealthy	201.1-338.5	2.1-1.3
Hazardous	>338.5	<1.3

# Visibility example





Decision making recommendations during wildfire season for

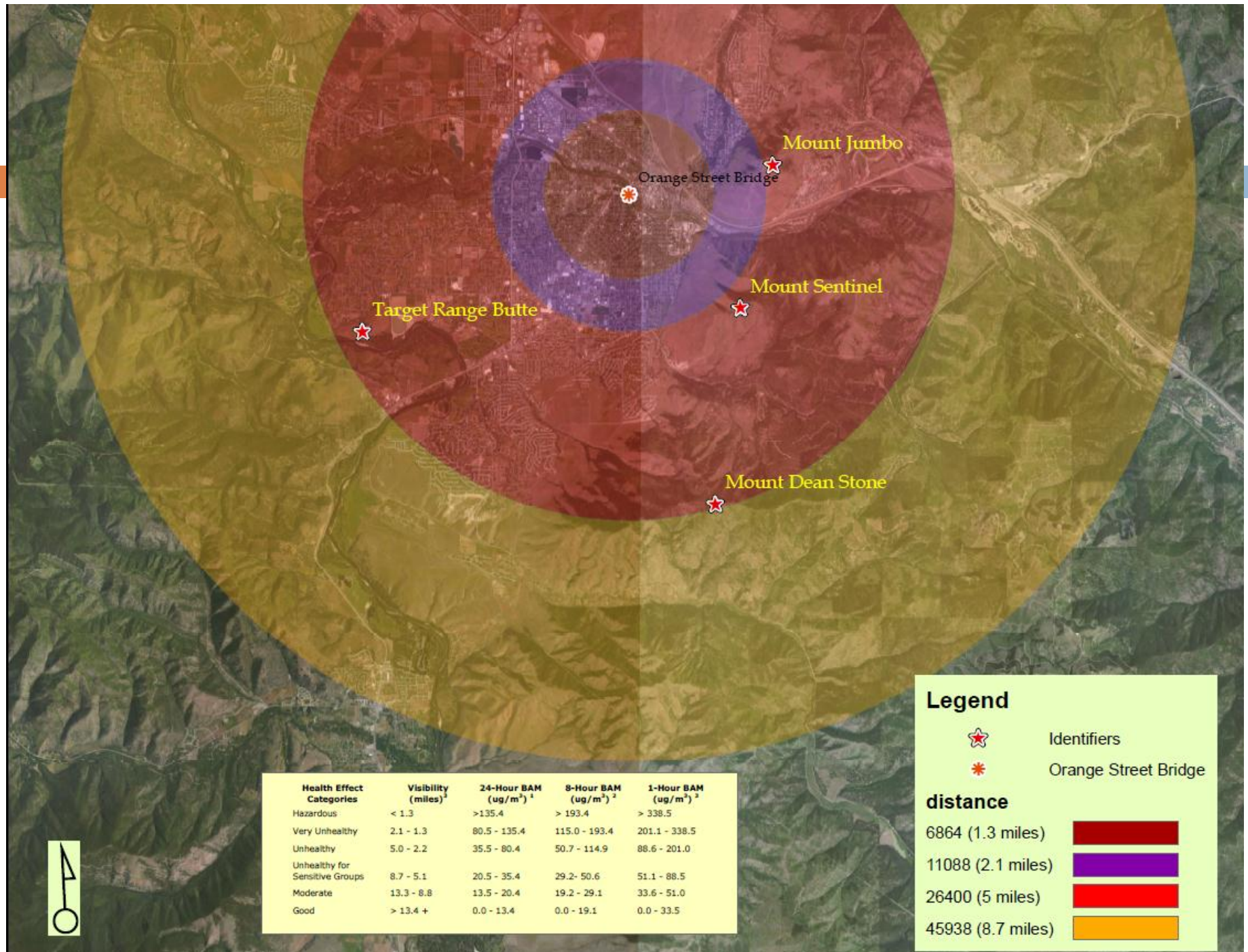
# Outdoor Sporting Events

based on visibility and air quality

Health Effect Category*	Visibility†	Recommendation
Good	13.4 miles and up	Hold outdoor sporting events as usual. Athletes with asthma should keep rescue inhalers at hand. Athletes with other smoke related sensitivities should take precautions as symptoms dictate.
Moderate/ Unhealthy for Sensitive Groups	5.1 to 13.3 miles	Hold outdoor sporting events as usual. Athletes with asthma should have rescue inhalers readily available and pretreat before exercise as directed by their healthcare provider. All athletes with respiratory illness should limit outdoor activity, monitor symptoms and reduce/cease activity if symptoms arise.
Unhealthy	2.2 to 5.0 miles	Consider postponing/delaying outdoor sporting events, especially high exertion activities like soccer and track and field. If possible, move athletic practices indoors. If event/practice is held, athletes with asthma or other respiratory illnesses are advised not to participate. All athletes should limit their outdoor activity for prolonged periods of time.
Very Unhealthy	1.3 to 2.1 miles	Consider postponing/delaying all outdoor sporting events. Move all athletic practices indoors. All athletes with asthma and other respiratory illnesses are advised to stay indoors. All others should avoid prolonged exertion outdoors.
Hazardous	1.3 miles or less	Cancel all outdoor sporting events or relocate to an indoor location. Move all athletic practices indoors.
<b>At all times, athletes experiencing respiratory symptoms should consult their personal healthcare provider</b>		

Montana's current wildfire guidance





Health Effect Categories	Visibility (miles) <sup>1</sup>	24-Hour BAM (ug/m <sup>3</sup> ) <sup>1</sup>	8-Hour BAM (ug/m <sup>3</sup> ) <sup>1</sup>	1-Hour BAM (ug/m <sup>3</sup> ) <sup>2</sup>
Hazardous	< 1.3	>135.4	> 193.4	> 338.5
Very Unhealthy	2.1 - 1.3	80.5 - 135.4	115.0 - 193.4	201.1 - 338.5
Unhealthy	5.0 - 2.2	35.5 - 80.4	50.7 - 114.9	88.6 - 201.0
Unhealthy for Sensitive Groups	8.7 - 5.1	20.5 - 35.4	29.2 - 50.6	51.1 - 88.5
Moderate	13.3 - 8.8	13.5 - 20.4	19.2 - 29.1	33.6 - 51.0
Good	> 13.4 +	0.0 - 13.4	0.0 - 19.1	0.0 - 33.5

Legend



Identifiers



Orange Street Bridge

distance

6864 (1.3 miles)



11088 (2.1 miles)



26400 (5 miles)



45938 (8.7 miles)



Questions?

